QUIET SYSTEM COOLING USING COUPLED OPTIMIZATION BETWEEN INTEGRATED MICRO POROUS ABSORBERS AND ROTORS

FIELD OF THE INVENTION

[0001] Embodiments of the present invention are directed to quieter cooling systems and, more particularly, to sound absorption for fan cooling of computing devices and the like.

BACKGROUND INFORMATION

[0002] Electronic components tend generate unwanted heat during use which should be channeled away from the device for proper operation. Heat sinks are often employed to radiate heat away from the device. Fans are also often used to more efficiently move heat away from the device to keep it cool and operating at a suitable temperature.

[0003] The trend to ultra thin notebooks and high density blade servers may make it more difficult to provide sufficient cooling with conventional airflow cooling, due to the space constraints. Smaller fans may thus be used running at higher speeds to move more air; however, this tends to create more acoustic noise.

[0004] Low acoustic noise may be important given end user preferences, eco labels, and emerging governmental procurement directives. The use of acoustic absorbers may allow for an increased airflow at the same noise level, but there is no room in the ultra thin systems for traditional, bulky acoustic absorbers such as foams.

[0005] Absorbing materials such as foams may be applied, but they are too bulky and do not fit in ultra thin form factors. In addition, the open cell foams lead to airflow loss in the system. Finally, these materials are relatively expensive and hard to integrate. Therefore, acoustic absorbers are usually not used in most electronic devices. Radial blowers and cross flow blowers are available, but they are not optimized and do not contain an integrated noise control solutions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The foregoing and a better understanding of the present invention may become apparent from the following detailed description of arrangements and example embodiments and the claims when read in connection with the accompanying drawings, all forming a part of the disclosure of this invention. While the foregoing and following written and illustrated disclosure focuses on disclosing arrangements and example embodiments of the invention, it should be clearly understood that the same is by way of illustration and example only and the invention is not limited thereto.

[0007] FIG. **1**A is a block diagram of an illustrative blower which may be used, for example, to cool a thin form factor computing device;

[0008] FIG. **1**B is a block diagram of the blower having a top cover comprising the micro-porous panel according to one embodiment of the invention;

[0009] FIG. **1**C is a cross sectional view of the blower taken along line A-A' of FIG. **1**B

[0010] FIG. **2** is a graph comparing sound absorption characteristics of a 32 mm foam absorber verses a 1.25 mm micro-porpus panel according on one embodiment;

[0011] FIG. **3** is a diagram showing airflow through a cross flow blower;

[0012] FIGS. **4**A and **4**B are fan blade rotors having 20 blades and 27 blades, respectively;

[0013] FIG. **5** is a graph showing pressure verses flow rate for a 20 blade rotor and a 27 blade rotor;

[0014] FIG. **6** is a graph illustrating a noise spectrum for a cross-flow blower; and

[0015] FIG. **6** is a graph showing noise reduction at various frequencies for a blower operating with the micro-porous panel absorber according to one embodiment.

DETAILED DESCRIPTION

[0016] Described are integrated micro porous absorber structures that may be tuned to attenuate noise at the blade pass frequency (BPF) of a cooling fan. Thus, the absorber may be 25 times thinner than a regular foam type absorber. Using this approach, a 1.25 mm thin absorber was designed and integrated that absorbs more than 65% of the sound energy. A regular foam absorber would have to be 32 mm thick in order to achieve this level of absorption. The extremely thin design of the micro porous absorber allows delivering about 10% more cooling and a 6 dB noise reduction, or 25% more airflow at the same acoustic noise level. This enables to meet the upcoming stringent acoustic noise directives, and a 15 to 25% increase in (turbo mode/system) power for ultra thin notebook and blade server platforms.

[0017] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0018] Referring now to FIG. **1**A, there is shown a blower which may be used for example to cool a thin form factor computing device. The blower may comprise a blower housing **100** and a fan **102**. This is of course a not-to-scale simplified diagram as a fan motor, vents, heat pipes, and any other items commonly found in blowers may also be present, though not shown. According to one embodiment of the invention, as shown in FIG. **1**B, a micro porous structure may be used to reduce noise associated with the blower. In this example, a micro porous blower cover **104** replaces the traditional blower cover. The micro-porous structure may be made out of, for example, perforated sheet metal, plastic or film, backed by an air layer. The material comprises a plurality of holes or perforations which may range in sizes and density.

[0019] FIG. **1**C shows a cross-sectional view taken along line A-A' from FIG. **1**B showing the blower housing **100**, the fan **102** and the micro-porous cover **104**. The micro-porous structure cover **104** may be backed by a thin air layer **106**. The size of the air-layer **106** may be fixed or changed dynamically by an actuator **108** to tune the acoustic properties of the micro-porous cover **104**. For example, one or more actuators **108** may be used to raise and lower the cover **104** changing the size of the air gap **106** and thus dynamically adjusting the acoustic properties of the cover for optimization of noise reduction. The actuators may be for example piezoelectric actuators **108** which moves the cover up and down as illustrated by arrow **110**.

[0020] The micro porous panel absorber or cover **104** comprises a thin sheet with micro perforations backed by a thin air layer **106** and may be fabricated using standard materials and